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HARVARD & SMITHSONIAN

New Discoveries in Late-Time Radio Emission in Tidal Disruption Events (TDEs)

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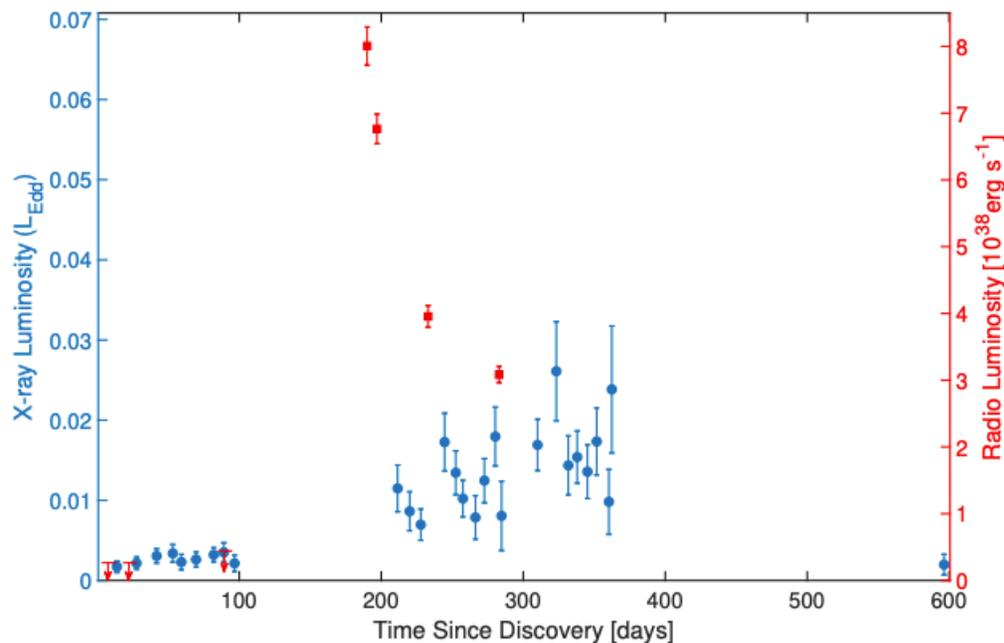
@whereisyvette



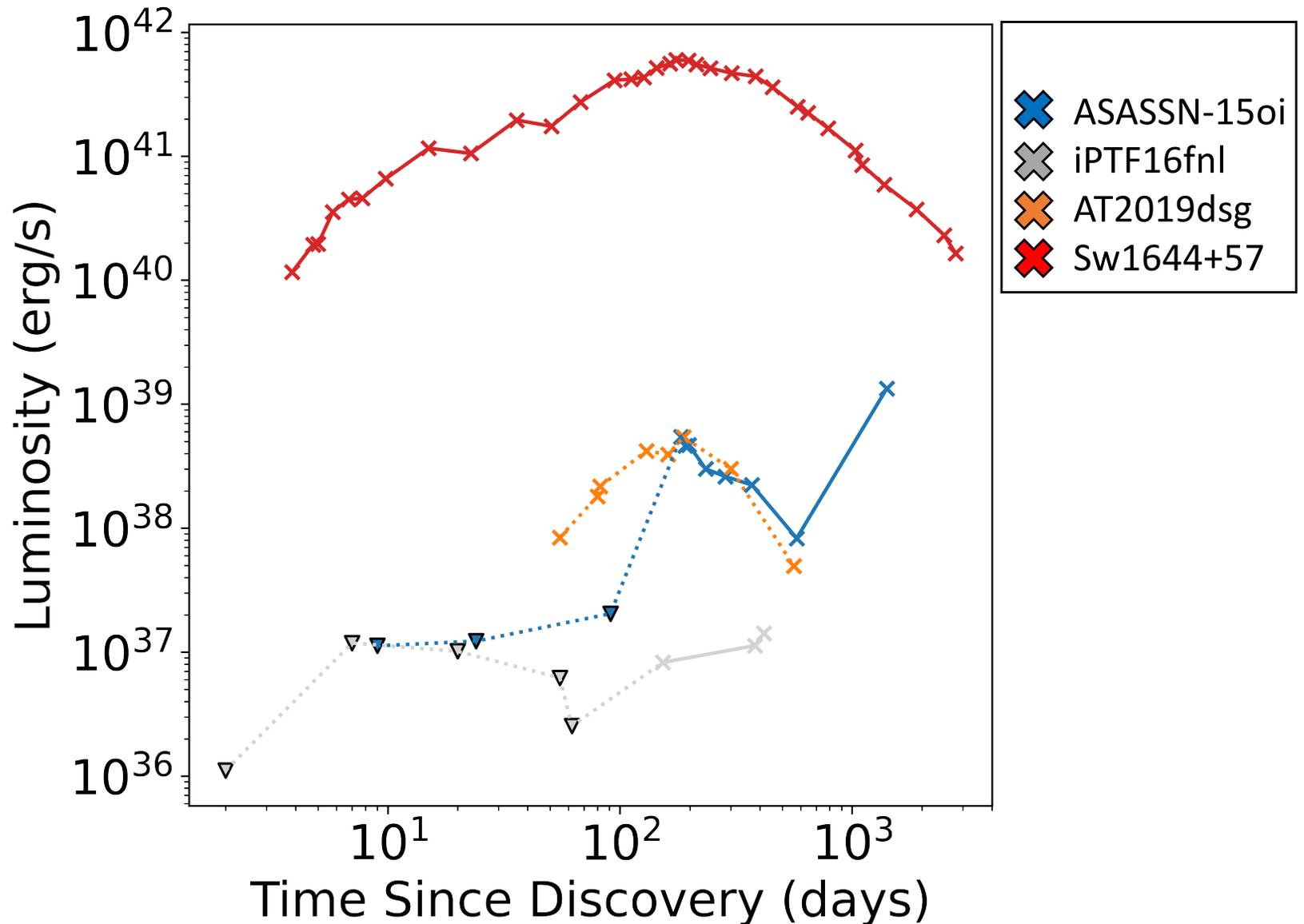
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Late-Time Emission

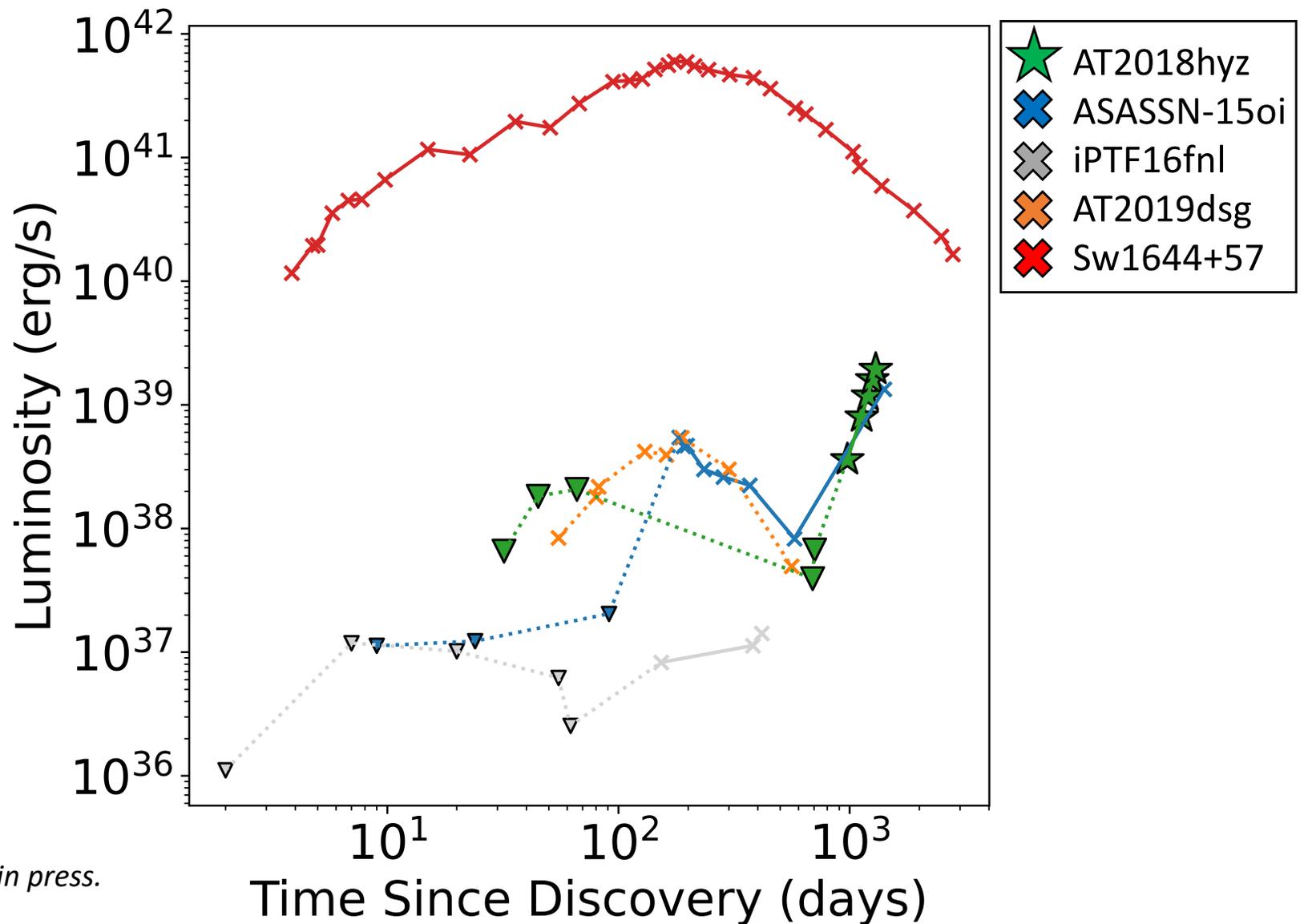
- Most radio TDE observations occur within the first 1-2 months. ~20% of TDEs are detected in radio during this time
- Recently, ASASSN-15oi (Horesh+2021), iPTF16fni (Horesh+2021b) became radio bright at >100 days (X-ray from 15oi more prompt, doesn't correlate). Is this common?
- To find out, we did a campaign with the VLA+MeerKAT of ~25 older TDEs (~2-3 years old) with no prior radio emission...



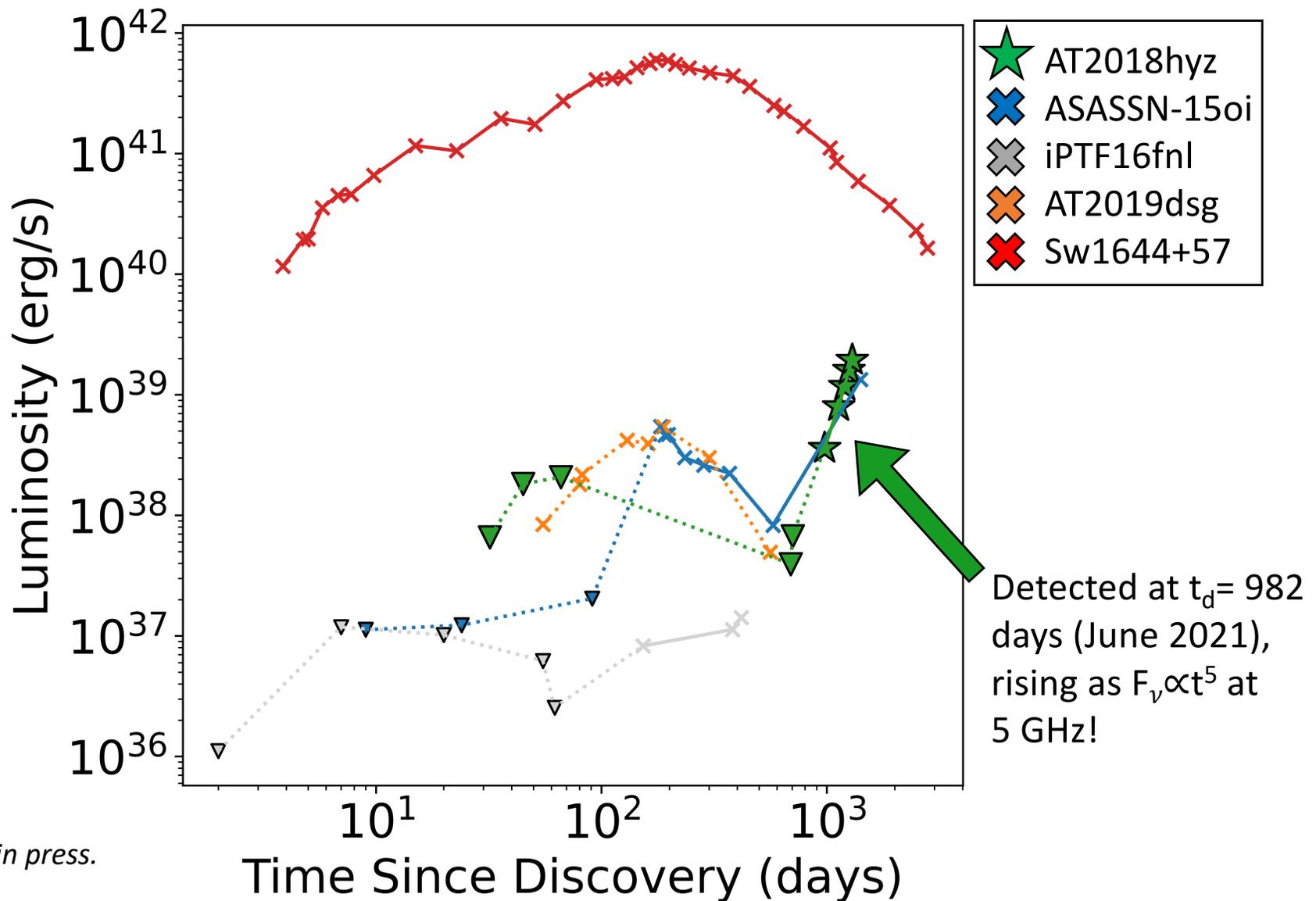
An Unusual Discovery: AT2018hyz



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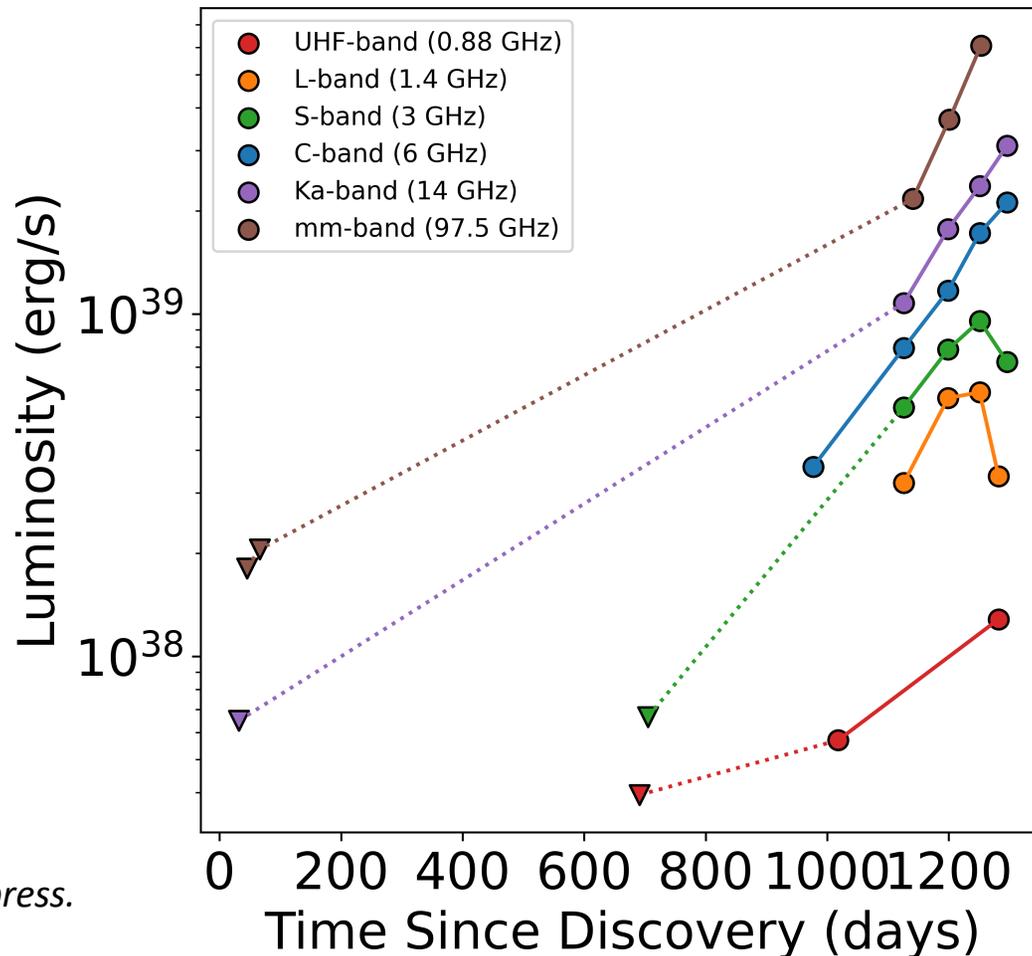


An Unusual Discovery: AT2018hyz



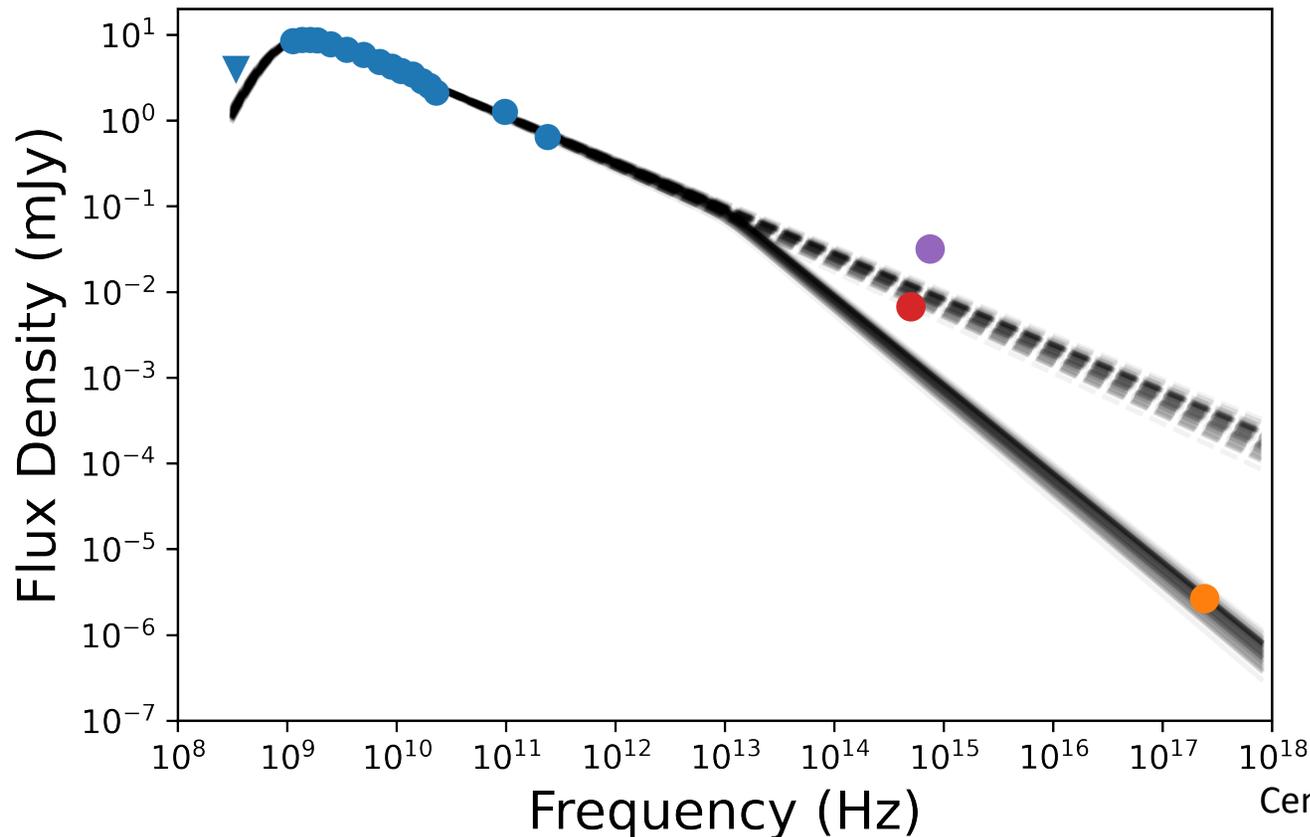
Observing AT2018hyz

- Monitoring with VLA+ALMA, MeerKAT+ATCA. Rising steadily at higher frequencies, rapid, sudden fading at lower (<3 GHz) frequencies in just 1 month
- Multi-frequency observations can be used to characterize physical properties of outflow



Observing AT2018hyz

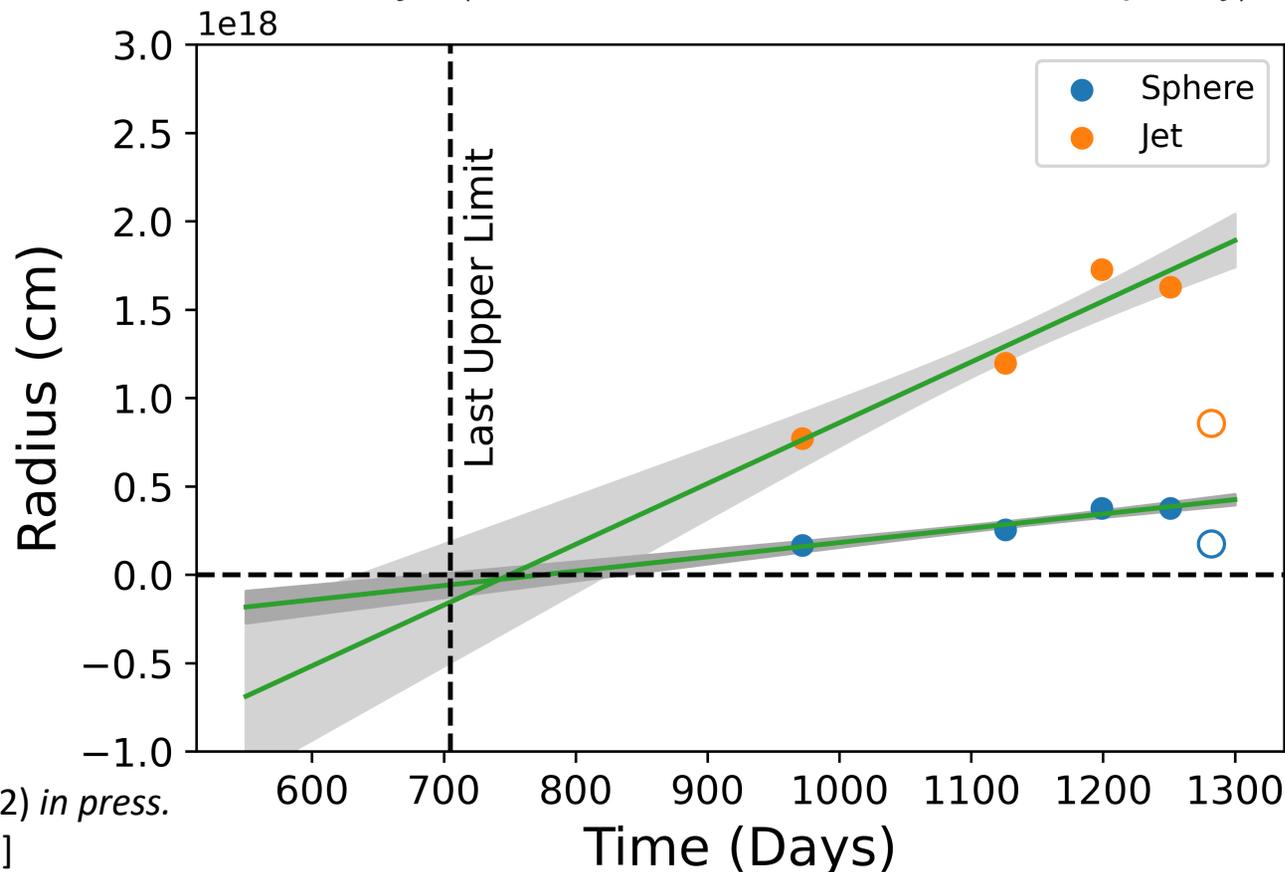
- Chandra DDT Observation on March 19 (15 ksec), + VLA, ALMA within 2 days. Photons detected! Flux is a factor of two lower than XMM observations at early times (Gomez+20)
- Indicates a cooling break upper limit at ~ 5 THz (5×10^{12} Hz), $\Gamma = 1.5 \pm 0.7$
- *Swift* UV data from Jan 2022, ZTF data, show UV+optical excess in emission.



Cendes et al. (2022) *in press*.
[arxiv:2206.14297]

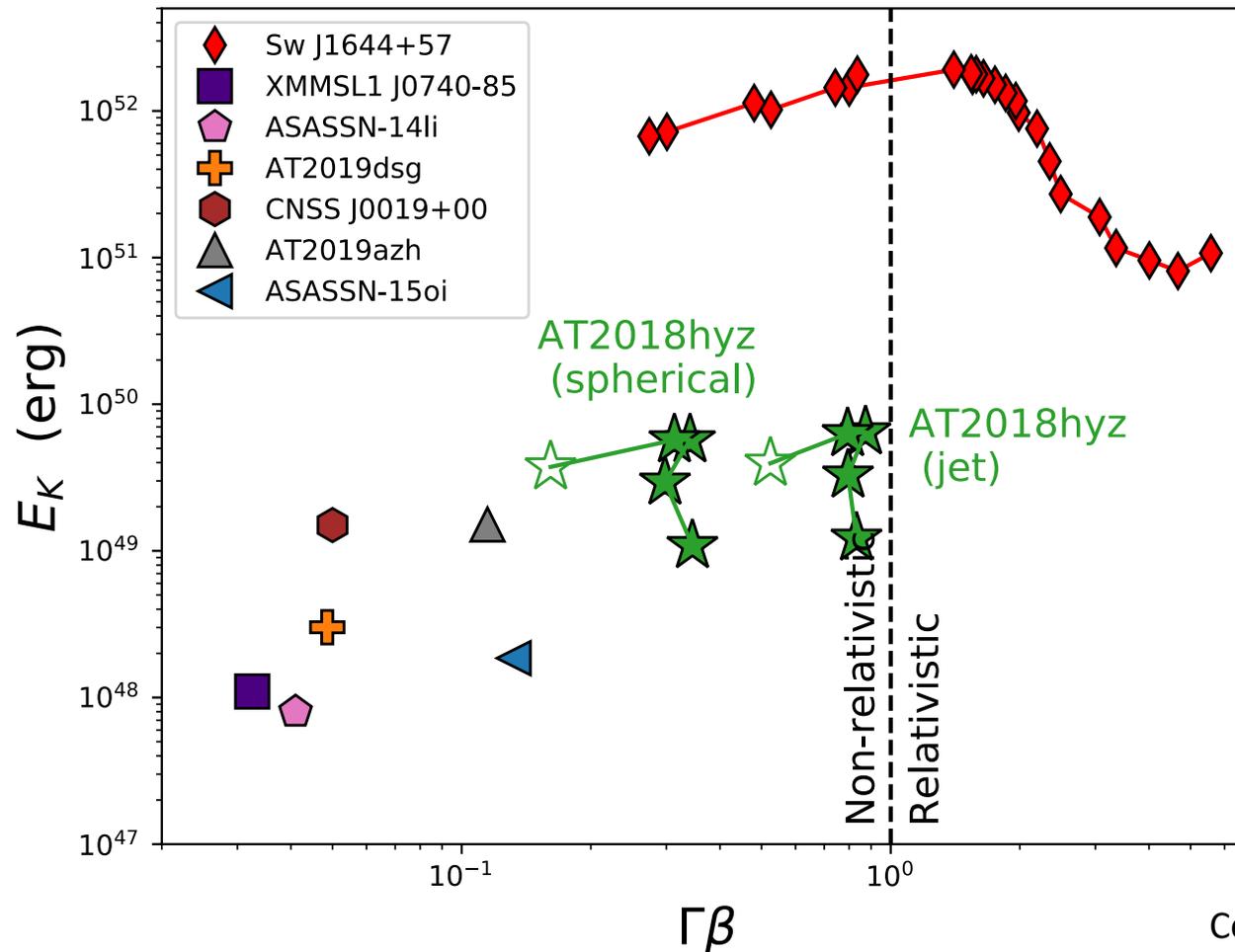
Estimating Date of Outflow

- Estimated volume of outflow matters: we consider the extremes of a spherical outflow, or a jet with 10° angle (similar to GRBs/ Sw1644+57)
- Spherical: max outflow velocity is $\beta \sim 0.2$. Jet: max outflow is $\beta \sim 0.6$! 🙄
- Extrapolating backwards, we find disruption date $t_d \approx 750$ days post-disruption
- Inconsistent with off-axis jet (emission starts too late, rises too quickly)

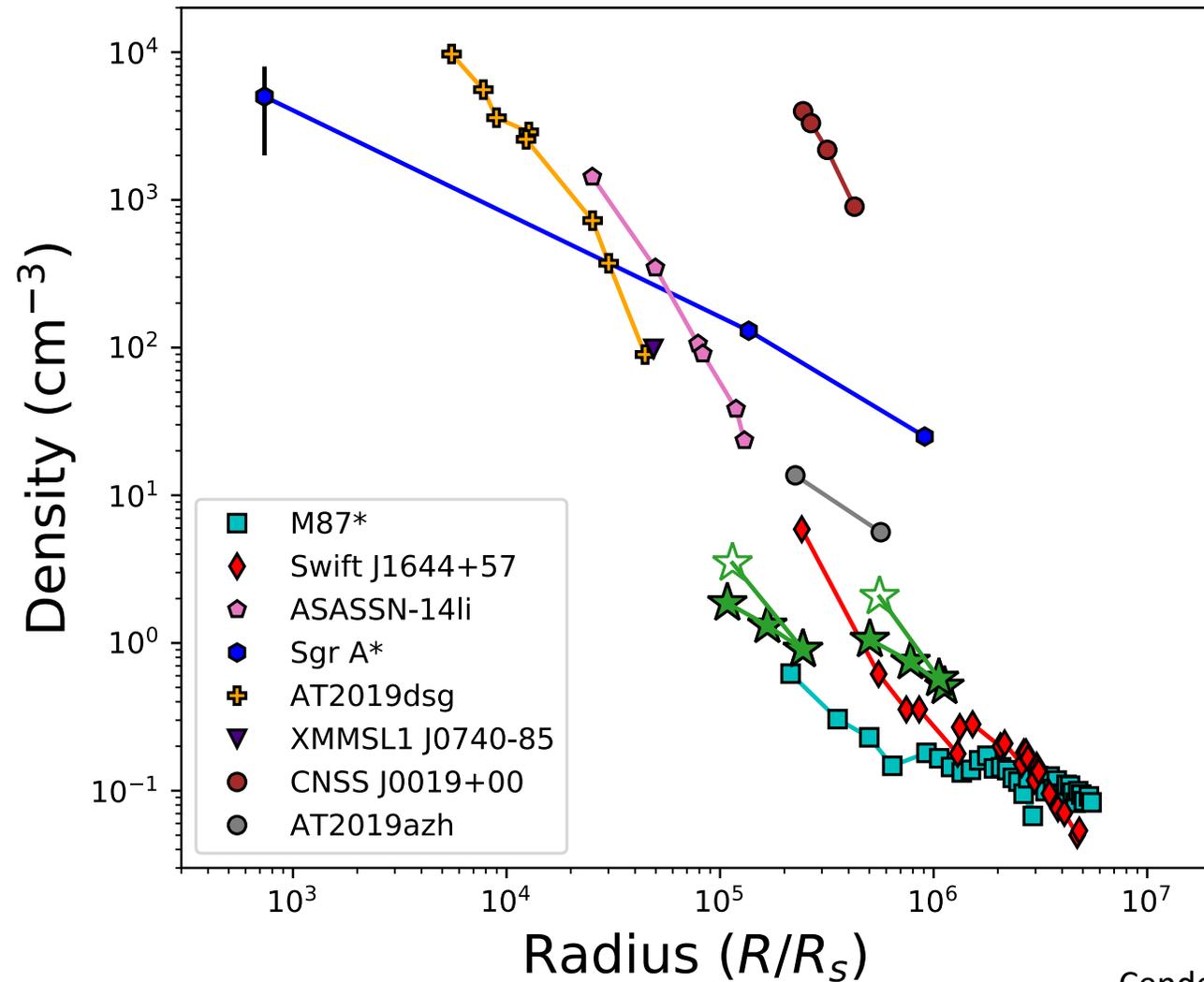


Energy/Velocity of the Outflow

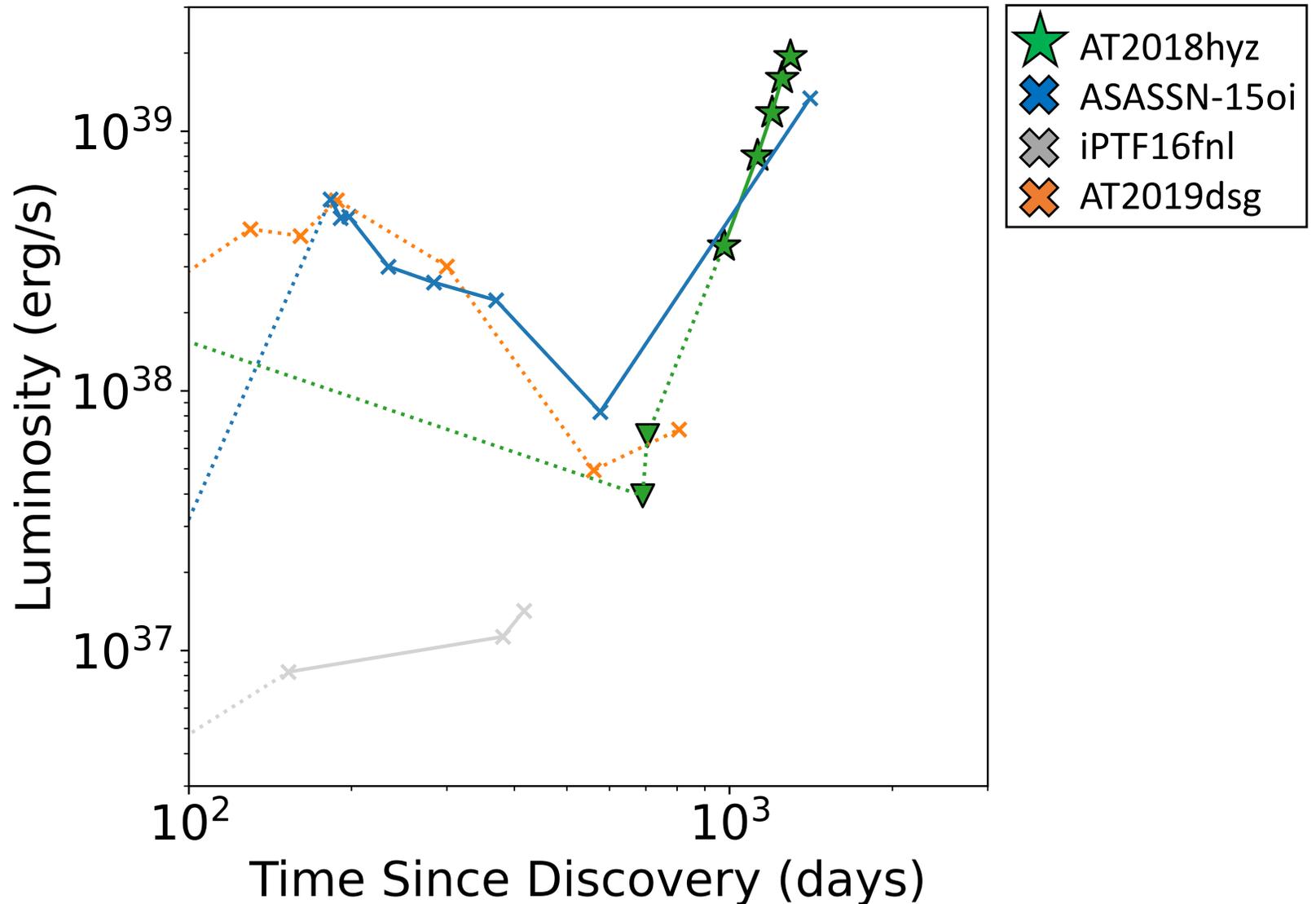
- AT2018hyz is mildly relativistic, and is between non-relativistic and relativistic TDEs
- The highest energy/velocity since Sw1644+57!



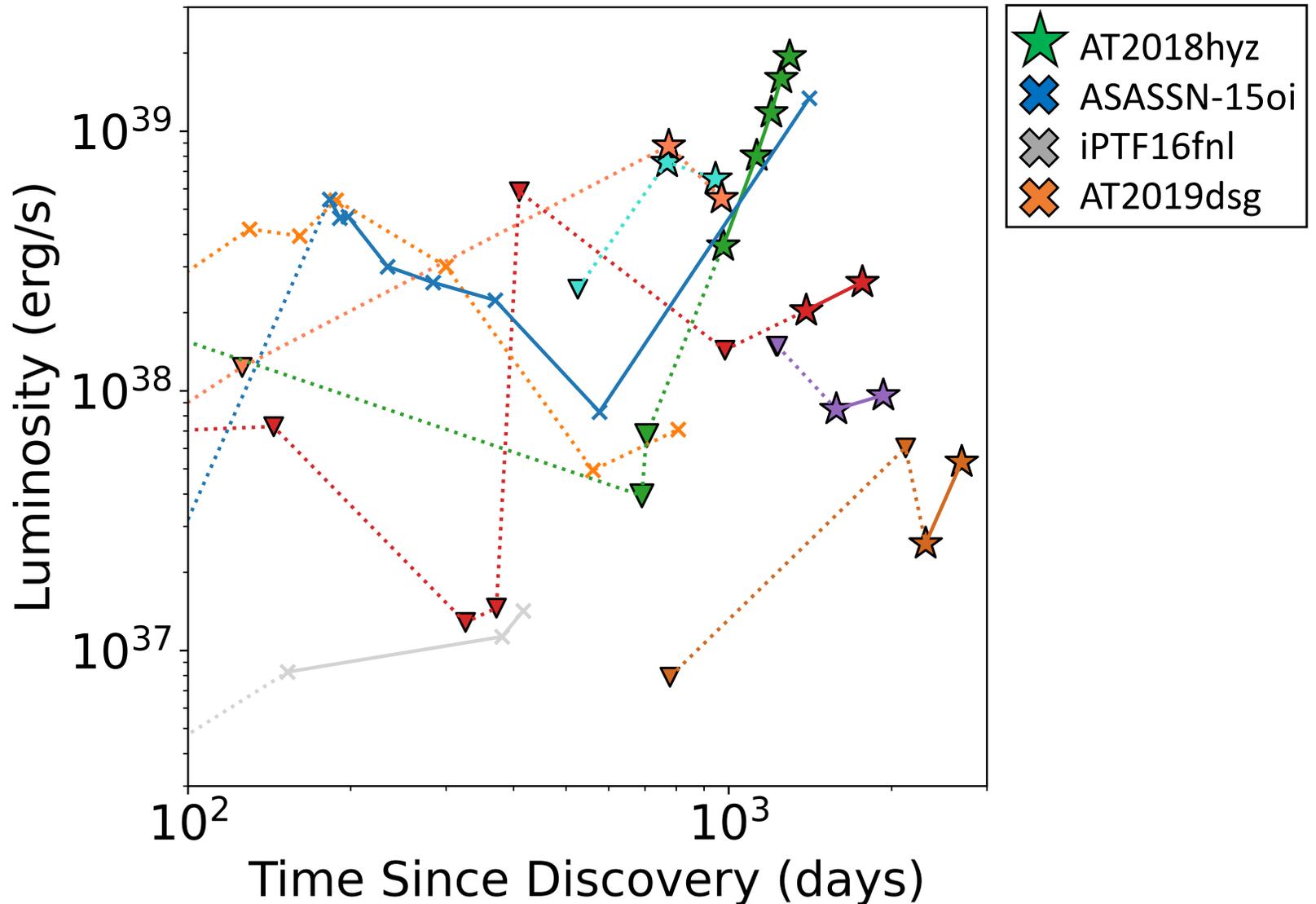
Density Profile



Looking Ahead: Other TDEs



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Outstanding Questions

- What is going on? This emission appears common, but was not expected, and physical picture around late-time TDEs is unclear. State change (a la X-ray binaries)? Debris circularization? Something else? We *need* more theoretical/computational work at \sim years post TDE time scales!

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- How common are (mildly) relativistic TDE outflows? We need to find more of them!
- What is happening at other wavelengths? Majority of this work is done in a single part of the EM spectrum, which does not paint a full picture. We need more observations, at all wavelengths! (And regular monitoring to know when it starts...)
- *Example:* What are X-rays doing, and are they coupled with radio? Swift J1644+57 is hard, but we have other TDEs where X-rays are thermal (accretion disc, or that plus corona? Changes at later times?).

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- Can we support ground-based observations more? See: exoplanets community, where NASA provides funding, resources to advance exoplanet science for space missions (thanks to Astro 2010 recommendation!)

